THE ROYAL AERONAUTICAL SOCIETY
WITH WHICH IS INCORPORATED THE INSTITUTION OF AERONAUTICAL ENGINEERS.

MONTHLY NOTICES,

JUNE, 1942.

Election of President.

Mr. A. Gouge, B.Sc., F.R.Ae.S., was elected President of the Society for the year October, 1942-October, 1943.

Election of Vice-Presidents.

Mr. E. F. Relf, F.R.Ae.S., A.R.C.Sc., and Dr. H. Roxbee Cox, D.I.C., B.Sc., F.R.Ae.S., were elected Vice-Presidents of the Society for the year October, 1942-October, 1943.

Society Meeting.

It is proposed to hold a meeting of the Society to discuss methods of Performance Calculation. The meeting will be arranged if a sufficient number of members express a wish for it. Will those members who would like to attend write in, therefore, to the Society?

Election of Members.

The following members were recently elected:—

Fellows.—Frederick Francis Crocombe (from Associate Fellow).

Associate Fellows.—Ronald John Atkinson (from Student), Jack Appleton Channer (from Student), Eric Vincent Hall (from Student), Attwood James Hobbs (from Student), Brian Robert Munn Hunter-Steen (from Graduate), Frederic John Jupp, Daniel Mackenzie, William Henry Ronald Moseley, Frank Marshall Reynolds (from Graduate), Henry Ernest Vincent (from Graduate).

Associates.—Kenneth Butler-Wheelhouse, Walter Gale, Gordon Hugh Godfrey Garbett, Frank Le Cheminant Hotton, Colin Ian McBeth, William James Macken, John Grossart Mackie, George Thomas Mickels, William Thorburn Reid, John Alfred Sizer, George Norman Thompson, Charles Frederick Toms (from Student), Frederick Eugene Weinel.

Graduates.—James Walter Agnew Andrews, Eric Oswald Draper, Bernard Glenister (from Student), Wilfred Henry Horton, John Alexander Ross (from Student).

Companion.—Robert Bisset Wight Scott.

Students.—William Frederick Cooper, Ronald Edward Bird, Derek Dudley Martin Butcher, John Richard Carter Fearon, Joseph Medd, Frederick William Pruden, Norman Scott, Arthur Godfrey Shove, Ronald Arthur Sutherland, Neville Richard Herbert Thompson, Philip John Wingham, Ivor Edward Woodroofe, Peter William Wreford-Bush.

Associate Fellowship New Syllabus Postponement.

The Council at their last meeting had under consideration the introduction in May, 1943, of the new syllabus for the Associate Fellowship examinations.

Notice was given some two years ago of the provisions of the new syllabus, but the increasing difficulties created by the war situation has caused the Council to decide to defer putting the new syllabus into operation until at least six months after the cessation of hostilities. The present syllabus will therefore be continued until further notice.

Any student who has been preparing for subjects, however, which appear in the new syllabus and not the old, will have a paper set in that subject, so he will not be penalised.

It should be noted that in agreement with other engineering institutions, it will be necessary before the examinations are taken, to have passed the Common Preliminary Examination or to have passed an exempting examination. Section A of the present syllabus is abolished as from January 1st, 1943.

Advertisements.

The fact that goods made of raw materials in short supply, owing to war conditions, are advertised in the Journal should not be taken as an indication that they are necessarily available for export.

Journal and Paper Shortage.

Many members of the Society working in official establishments or in firms have opportunities of seeing the Journal apart from the copy to which they are entitled. The severe shortage of the supply of paper is making the printing of the Journal more and more difficult and it has been suggested that those members who can otherwise see the Journal may be prepared to give up their own copy for the period of the war. If a sufficient response is received to the suggestion it will enable the Journal to keep closely to the standard it has set. It may have the further effect of enabling some reduction to be made in the subscriptions of those who do not receive the Journal, though this a matter for final decision of the Council after the position has been reviewed and cannot be looked upon as a foregone conclusion.

Changes of Address.

Members are urged to notify any change of address at once, as in future JOURNALS which are lost in the post cannot be replaced.

Graduates' and Students' Section.

The following lectures have been arranged for the Graduates' and Students' Section to be held in the Library at 4, Hamilton Place, W.1, at 7.30 p.m. Senior members of the Society are invited and non-members wishing to attend must apply in writing to the Secretary of the Society.

June 17th.—Lecture by Mr. F. H. M. Lloyd, A.F.R.Ae.S., on "The Design of Fighter Aircraft."

July 15th.—Lecture by Mr. F. Lane on "Speed." Illustrated by films.

Additions to the Library.

Pamphlets in italics, with location reference following in brackets.
Books marked * may not be taken out on loan.

BB.b.95.—*What Airplanes can do: Present Limitations and Future Developments. By Edward Warner. (Reprint from "Foreign Affairs," U.S.A.)* (PBB.1.b.5.)

E.b.90.—Theory and Design of Structures. (5th Ed.) By Ewart S. Andrews. Chapman and Hall. 1942. 15/-.

E.f.91.—Airframes. (2nd Ed.) By J. C. Corlett. Sir Isaac Pitman and Sons. 1942. 6/-.

E.f.92.—Aero Engines: Overhaul, Testing and Installation. By O. Caudwell. Sir Isaac Pitman and Sons. 1942. 6/-.

*G.b.3.—*British Standards Institution: Specifications*:—
No. A.20. Spline Shafts and Holes. 1942. 1/-.
No. 5W.2. Flexible Wire Rope. (Amendment Slip.)

G.e.A.78.—*Handling, Storing and Transporting Wrought Aluminium Alloys. Wrought Light Alloys Development Association.* 1942. (PG.3,a.14.)

G.e.B.19.—*Classification of Copper and Copper Alloys. Copper Development Association. Publication No.* 36. 1942. (PG.3.b.9.)

G.e.E.54.—*The Mechanical Properties of Nickel Alloy Steels. Mond Nickel Co. Publication No. A.*11. (*Undated.*) (File Case.)

G.e.J.19.—Second Report on Refractory Materials. Iron and Steel Institute. Special Report No. 28. 1942. 16/- (10/- to Members of I.S.I.)

I.a.27.—Modern Trigonometry. M. J. G. Hearley. Thos. Nelson and Sons. 1942. 5/-.

J.g.190.—*Elementary Meteorology for Aviators (Part I). Longmans, Green and Co.* 1942. 1/-. (PJ.1.b.15.)

J.g.191.—*Smithsonian Miscellaneous Collections*:—
Vol. 101, *No.* 12 (*Publication No.* 3,678). The Quantity of Vaporous Water in the Atmosphere. By C. G. Abbot. 1942. (Y.30.i.)

J.g.192.—Weather Study. By David Brunt. Thos. Nelson and Sons. 1942. 5/-.

L.d.75.—*Examples and Exercises in Elementary Air Navigation. By M. J. Hearley. Longmans, Green and Co.* 1942. 1/-. (PL.1.b.6.)

L.e.9.—Maps and Elementary Meteorology for Airmen. By W. Myerscough. Sir Isaac Pitman and Sons. 1942. 3/6.

M.b.45 and 46.—*Extracts from speeches by Capt. L. F. Plugge in the House of Commons*:—
(1) *The Aether as the 20th Century Battlefront.* (3/7/41.)
(2) *The Aether as a means to win back the French Colonial Empire to our Cause.* (17/2/42.) H.M.S.O. 1942. (Y.20.i.)

*M.c.54-59.—*Ministry of Aircraft Production, Official Reports: Wireless Installations on Enemy Aircraft: Ju.* 87*B*2, *Ju.* 88, *He.* 111*H*, *Me.* 109; *two Emergency Transmitters.* (Y.18.ii.1-6.)

N.a.66.—Mechanical Physics. By Herbert Dingle. Thos. Nelson and Sons. 1942. 5/-.

Q.d.52.—*Extract from speech by Captain Plugge in the House of Commons: Speed of Merchant Ships.* 1942. *H.M.S.O.* (Y.20.i.)

S.b.110.—*Parliamentary Debates: House of Commons Official Repart. Vol.* 378, *No.* 40. *Air Estimates,* 1942. *H.M.S.O.* 1942. 6*d.* (Y.20.ii.)

S.d.76.—The History of Combat Airplanes. By C. G. Grey. Norwich University, Vermont, U.S.A. (James Jackson Cabot Publication No. 7.) 1942.

S.e.34.—Arise to Conquer. By Wing-Commander Ian Gleed. Victor Gollancz. 1942. 8/6.

*UU.c.—*National Advisory Committee for Aeronautics, U.S.A. Technical Memoranda*:—
No. 1,008. Correlation of Data on the Statistical Theory of Turbulence. By K. Wieghardt. (From Luftfahrtforschung, Feb., 1941.)
No. 1,010. Analytical Theory of the Campini Propulsion System. By S. Campini. (From Aerotecnica, Jan., 1938.)

*V.5/46.—Institution of Mechanical Engineers. Proceedings, Vol. 146 (July-December, 1941).

Y.24.—*Tin Research Institute. Publications*:—
No. 109. Report for 1941.

J. Laurence Pritchard, *Secretary and Editor.*

PINNED-PINNED SLENDER SOLID STRUTS WITH PARABOLIC TAPER.

By F. J. Turton, B.Sc., A.R.C.Sc.,

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§1. Introductory.

In 1917-19, Barling and Webb (1) (3), Berry, Cowley and Levy (2), and Webb and Lang (4) discussed the elastic stability of struts of various tapers, but it appears to have escaped notice that one of the few cases in which formal integration is possible is that in which the tapered profile of axial longitudinal sections is part of a parabola; this gives a " homogeneous linear " differential equation, *i.e.*, a linear equation of the form $f(xd/dx)\,y=F(x)$.

The only case discussed in this paper is the pinned-pinned strut; this is important as a saving in weight (and in air-resistance) is possible as compared with a uniform strut of the same strength and having similar transverse sections, as well as a possible indirect saving by the use of smaller end fittings. But the solution can be applied at once to obtain a similar saving in weight (and air-resistance) for (*a*) a clamped-free strut, corresponding to one-half of the pinned-pinned strut; (*b*) a clamped-clamped strut, of which the middle half corresponds to a pinned-pinned strut. Parabolic taper with a clamped-pinned strut does not give a saving in weight.

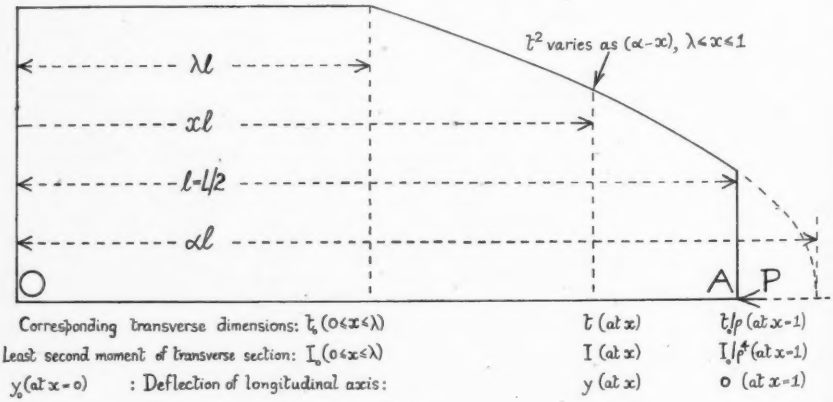


Fig. 1.

It is assumed that transverse sections are similar and similarly situated with respect to a longitudinal axis, $A'OA$, through their centroids, that the strut is symmetrical about the transverse section through O, and that the thrust P is applied axially at A and A'. It is to be expected, as with conical taper, that increased saving in weight will be obtained by having a central uniform portion, so this is the case discussed. The variables used are shown in Fig. 1.

In §2 the mathematical problem is discussed, the relation giving the critical load is found, and the method of solution employed is explained. In §3 an

expression is found for the saving in weight and in §4 the results for the strut with no uniform central portion are briefly quoted. In Fig. 2, the strength of the strut and the saving in weight can be read off directly for any value of λ (see Fig. 1) and a number of values of ρ, within the range giving a saving in weight of $12\frac{1}{2}$ per cent. or more. In Fig. 2 the saving in weight is compared with that obtained by previous investigators with other forms of taper, and in §5 the results are briefly discussed.

§2. Mathematical Solution.

For $o \leqslant x \leqslant \lambda$, $EI_o y'' + Pl^2 y = o$, hence

$$y = B \cos kx + D \sin kx \text{ where } k^2 = Pl^2/EI_o.$$

By symmetry,

$$y' = o \text{ when } x = o, \therefore D = o, \text{ giving } y = B \cos kx \quad . \quad . \quad (1)$$

For $\lambda \leqslant x \leqslant 1$, t^2 varies as $(\alpha - x)$, hence I varies as $(\alpha - x)^2$. Therefore

$$I_o/(I_o/\rho^4) = (\alpha - \lambda)^2/(\alpha - 1)^2$$

whence

$$\frac{(\alpha-\lambda)}{(\alpha-1)} = \rho^2, \frac{(\alpha-1)}{(1-\lambda)} = \frac{1}{(\rho^2-1)}, \frac{(\alpha-\lambda)}{(1-\lambda)} = \frac{\rho^2}{(\rho^2-1)} \quad . \quad . \quad . \quad (2)$$

Also

$$EIy'' + Pl^2 y = o, \text{ or } (\alpha - x)^2 y'' + k^2 (\alpha - \lambda)^2 y = o.$$

Put

$$z = \alpha - x \text{ and } D = d/dz, \text{ then } \{ z^2 D^2 + k^2 (\alpha - \lambda)^2 \} y = o.$$

$$z^m \text{ is a solution if } m(m-1) + k^2 (\alpha - \lambda)^2 = o \quad . \quad . \quad (3)$$

$$\text{or if } m = (1 \pm i\mu)/2 \text{ say, where } \sqrt{(\mu^2+1)}/2 = k(\alpha - \lambda) \quad . \quad . \quad (4)$$

$$\sqrt{(\mu^2+1)}/2 = k(1-\lambda)\rho^2/(\rho^2-1) \text{ from } (2) \quad . \quad . \quad . \quad (4a)$$

μ may be real, imaginary or zero.

If μ is not zero,

$$y = \sqrt{(\alpha - x)} \left[Q \cos \{ \tfrac{1}{2}\mu \log (\alpha - x) \} + R \sin \{ \tfrac{1}{2}\mu \log (\alpha - x) \} \right].$$

Now y is continuous at $x = \lambda$, hence

$$B \cos k\lambda = \sqrt{(\alpha - \lambda)} \left[Q \cos \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} + R \sin \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} \right] \quad (5)$$

Also y' is continuous at $x = \lambda$, hence

$$kB \sin k\lambda = \sqrt{(\alpha - \lambda)} \, (\tfrac{1}{2}\mu/(\alpha - \lambda) \left[-Q \sin \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} \right.$$
$$\left. + R \cos \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} \right] + \left[Q \cos \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} \right.$$
$$\left. + R \sin \{ \tfrac{1}{2}\mu \log (\alpha - \lambda) \} \right] / 2\sqrt{(\alpha - \lambda)} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Finally, $y = o$ when $x = 1$, giving

$$o = Q \cos \{ \tfrac{1}{2}\mu \log (\alpha - 1) \} + R \sin \{ \tfrac{1}{2}\mu \log (\alpha - 1) \} \quad . \quad . \quad (7)$$

Dividing corresponding sides of (6) and (5), replacing Q and R by proportionate quantities from (7), and using the addition theorems, we get, as the condition for buckling,

$$2(\alpha - \lambda) k \tan k\lambda = 1 + \mu \cot \{ \tfrac{1}{2}\mu \log ((\alpha - \lambda)/(\alpha - 1)) \}$$

whence, using (4), (4a) and (2)

$$\sqrt{(\mu^2+1)} \tan \left[\{ \lambda (\mu^2+1)^{\frac{1}{2}} (p^2-1) \} / \{ 2p^2 (1-\lambda) \} \right] = 1 + \mu \cot (\mu \log p) \quad (8)$$

(a) If $\lambda = o$, *i.e.*, if the parabolic taper extends to the centre, then

$$1 + \mu \cot (\mu \log \rho) = o \text{ or } -\mu = \tan (\mu \log \rho); \quad . \quad . \quad (9)$$

the least real value for $(\mu \log \rho)$ is evidently between $\pi/2$ and π and a first approximation is readily found graphically.

Re-writing (9) as $\mu = \tan (\pi - \mu \log \rho)$ gives $\mu = [\pi - \tan^{-1} \mu]/\log \rho$, which form is convenient for iteration.

If μ is imaginary, equal to $i\mu_1$, say, (9) becomes $-\mu_1 = \tanh (\mu_1 \log \rho)$ which gives no real values of μ_1 other than zero.

If μ (or μ_1) is zero, the auxiliary equation (3) has equal roots, $\frac{1}{2}$, $\frac{1}{2}$, and it is necessary to repeat the analysis with

$$y = \sqrt{(\alpha - x)}\,\{ S + T \log (\alpha - x) \}\,.$$

It is found that

$$2(\alpha - \lambda)\, k \tan k\lambda \text{ is then } [2 + \log \{ (\alpha - \lambda)/(\alpha - 1) \}\,]/\log \{ (\alpha - \lambda)/(\alpha - 1) \}\,.$$

So that when $\lambda = 0$, $\log \{ \alpha/(\alpha - 1) \} = -2$, which is impossible for real values of α.

Thus when $\lambda = 0$, the critical load for the strut is given by the least real root of (9). Some numerical results are given in §4.

(*b*) If $\lambda \neq 0$, equation (8) is not readily solved for μ. But we can insert values for μ (using the values determined when $\lambda = 0$ as a starting-point and noting that the strength of the strut will increase steadily with λ for a given ρ) and calculate $\lambda/(1 - \lambda)$ and thence λ, by putting (8) in the form

$$\lambda (1 - \lambda) = [2p^2/\{ (p^2 - 1)(\mu^2 + 1)^{\frac{1}{2}} \}\,] \tan^{-1} [\{ 1 + \mu \cot (\mu \log p) \}\,/(\mu^2 + 1)^{\frac{1}{2}}]$$

The strength of the strut is then found from (4*a*).

§3. Saving in Weight.

(*a*) Volume of the Tapered Strut.

The area of the transverse section at x, $\lambda \leqslant x \leqslant 1$, may be written $c(\alpha - x)$, c being some constant; the area in the uniform central portion is Ct_0^2, C being some constant; and the common value at $x = \lambda$ gives $c(\alpha - \lambda) = Ct_0^2$.

The volume of the strut is therefore

$$2Ct_0^2 \lambda l + 2\int_{\lambda l}^{l} c(\alpha - x)\, d(xl).$$

Integrating, substituting for $(\alpha - 1)/(\alpha - \lambda)$ from (2), and for c, the volume is found to be $Ct_0^2 l\,\{ \rho^2 + 1 + \lambda(\rho^2 - 1) \}\,/\rho^2$.

(*b*) Uniform Strut with Similar Transverse Sections and Same Buckling Load.

If t_u in this strut corresponds to t_0, the volume is $2Ct_u^2 l$. If the least second moment of its transverse sections be I_u, then for the same buckling load, P,

$$\frac{Pl^2}{EI_u} = \frac{\pi^2}{4} \text{ and from (4) } \frac{Pl^2}{EI_0} = \frac{\{ (\mu^2 + 1)(\rho^2 - 1)^2 \}}{\{ 4\rho^4 (1 - \lambda)^2 \}}$$

hence

$$\frac{t_0^4}{t_u^4} = \frac{I_0}{I_u} = \frac{\{ \pi^2 (1 - \lambda)^2 \rho^4 \}}{\{ (\mu^2 + 1)(\rho^2 - 1)^2 \}}$$

giving

$$\frac{t_0^2}{t_u^2} = \frac{\{ \pi (1 - \lambda) \rho^2 \}}{\{ (\rho^2 - 1)\sqrt{(\mu^2 + 1)} \}}$$

Hence the ratio

$$\frac{\text{Volume of tapered strut}}{\text{Volume of similar uniform strut of the same strength}} = \frac{Ct_0^2 l\,\{ \rho^2 + 1 + \lambda(\rho^2 - 1) \}\,/\rho^2}{2Ct_u^2 l}$$

$$= \{ \pi (1 - \lambda)/2(\mu^2 + 1)^{\frac{1}{2}} \}\,\{ \lambda + (\rho^2 + 1)/(\rho^2 - 1) \}$$

The percentage of weight saved is therefore

$$100\,[1 - \{ \pi (1 - \lambda)/2(\mu^2 + 1)^{\frac{1}{2}} \}\,\{ \lambda + (\rho^2 + 1)/(\rho^2 - 1) \}\,]$$

§4. Results when $\lambda = 0$, *i.e.*, when the Parabolic Taper Extends to the Centre:—

ρ	1.2	1.4	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
μ	9.21	5.23	3.88	3.49	3.19	2.96	2.77	2.61	2.48	2.37	2.27	2.18	2.11	2.04	1.98	1.92	1.88
Saving in wt. %	5.96	9.04	10.51	10.87	11.05	11.05	11.01	10.84	10.62	10.34	10.01	9.66	9.28	8.88	8.40	8.05	7.62

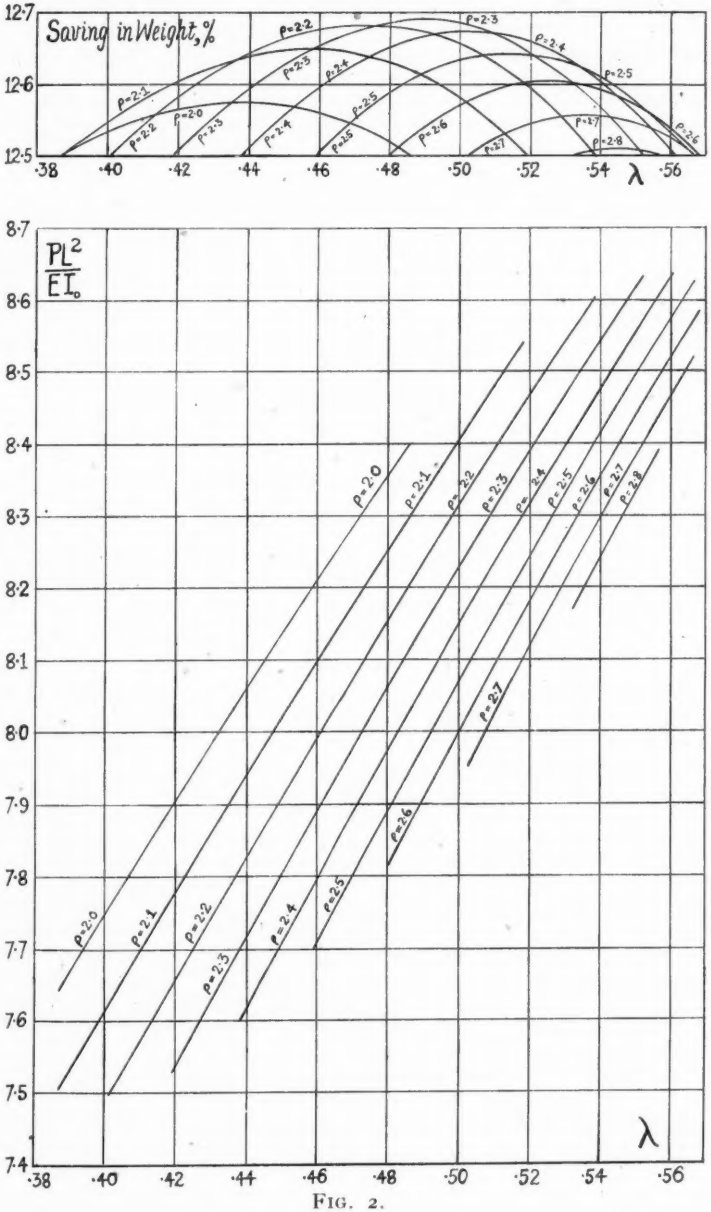
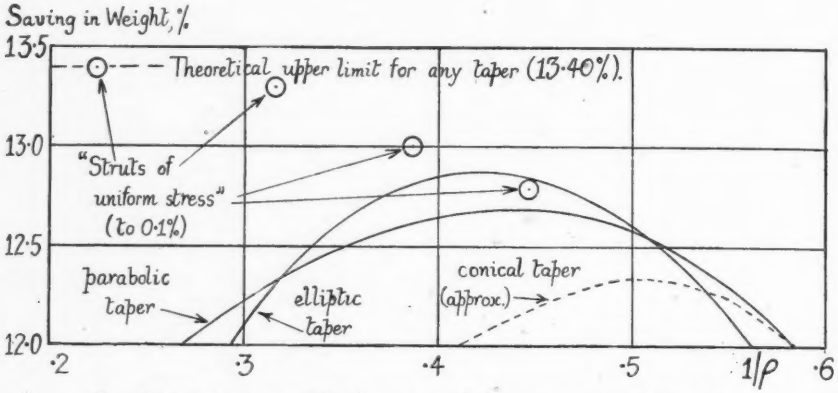

Saving in Weight, %
12·7
12·6
12·5
ρ=2·2
ρ=2·3
ρ=2·4
ρ=2·5
ρ=2·6
ρ=2·7
ρ=2·8
ρ=2·1
ρ=2·0
·38
·40
·42
·44
·46
·48
·50
·52
·54
λ
·56
PL²/EI₀
8·7
8·6
8·5
8·4
8·3
8·2
8·1
8·0
7·9
7·8
7·7
7·6
7·5
7·4
ρ=2·0
ρ=2·1
ρ=2·2
ρ=2·3
ρ=2·4
ρ=2·5
ρ=2·6
ρ=2·7
ρ=2·8
λ

FIG. 2.

§5. $\lambda \neq 0$.

Fig. 2 gives the buckling load for a parabolically tapered strut for any λ and values of ρ at intervals 0.1, for which the saving in weight is 12½ per cent. or more. The greatest saving is about 12.69 per cent., near $\lambda=0.49$ and $\rho=2.3$, but being at a mathematical maximum, the saving is little less for a region around these values. This compares with a maximum of 12.35 per cent. for conical taper, 12.88 per cent. for elliptical taper and 13.40 per cent. for the "calculus of variations" strut and the limit for "struts of uniform stress."



Greatest saving in weight for values of $1/\rho$ = ratio of corresponding linear dimensions of end and central sections, for various forms of tapered solid struts.

FIG. 3.

In Fig. 3 the saving in weight for parabolic struts now calculated is compared, for different values of $1/\rho$, with that for (i) conical taper: this is rather rough, the values being estimated from Webb and Lang's graphs; (ii) elliptic taper, recalculated by the writer to the necessary accuracy; and (iii) the few Barling and Webb values for "struts of uniform stress" given to 0.1 per cent.; unfortunately, for such struts of little taper, the saving is only stated to 1 per cent., and although the volume ratio is quoted to three figures, the strength is not quoted at all!

It will be noted that elliptic taper gives a greater saving than parabolic taper for $0.32 < 1/\rho < 0.5$, but parabolic taper is better than either elliptic or conical for a range on either side of this range. Parabolic taper shares with conical taper the further advantage that machining is confined to a portion of the strut, varying from $0.44\,L$ to $0.61\,L$, according to the value of ρ, for a saving of 12½ per cent. or more. It must be remembered that the points for conical and for parabolic taper in this figure are *not* for the same value of λ, but for that value of λ which gives the greatest saving in weight for the value of ρ at the point.

It will be noted that one Barling and Webb value (for a "strut of uniform stress") is actually less than the value for elliptic taper at the place. This difference is just too much to be accounted for by rounding off errors and the writer can only conclude that Barling and Webb's values are not reliable to the number of figures quoted. This is certainly the case in the last line of p. 875[1], where x/l is calculated from $\pi x/2l = \cos^{-1}(t/t_0) + (t/t_0)\sqrt{(1-t^2/t_0^2)}$; the value for $l/t_0=0.643$ is not rounded off to the nearer alternative and that for $t/t_0=0.5$ is more than 1½ too large in the last place.

From the trend of the Barling and Webb points marked, however, it would seem that the " strut of uniform stress " gives very little more saving in weight than the elliptically tapered strut when $0.45 < 1/\rho < 0.5$ and very little more than the parabolically tapered strut in the range $0.5 < 1/\rho < 0.58$.

Having determined on λ and ρ, the profile of longitudinal sections of a strut of parabolic taper is very easily found. Thus Fig. 1 has been drawn to represent (with greatly magnified transverse dimensions) the approximately best form from the point of view of saving weight, viz., $\lambda=0.49$, $\rho=2.3$. Then from (2), $\alpha=1+(1-\lambda)/(\rho^2-1)=1.11888$. Also $t^2/t_0^2=(\alpha-x)/(\alpha-\lambda)$, so that

$$t/t_0=\sqrt{\{(1.11888-x)/0.62888\}}=\sqrt{(1.77916-1.59013\,x)}$$

from which values at any point are readily calculated.

References.

1. Barling and Webb. R. & M. 343, June 1917.
2. Cowley and Levy. R. & M. 484, September 1918.
3. Barling and Webb. J. Roy. Aero. Soc., October 1918.
4. Webb and Lang. J. Roy. Aero. Soc., April 1919.

REVIEWS.

EXAMPLES AND EXERCISES IN ELEMENTARY AIR NAVIGATION.

ELEMENTARY METEOROLOGY FOR AVIATORS. PART I.

By M. J. Hearley. Longmans, Green and Co. 1942. 1/- each.

Here are two more pamphlets in the series intended for Air Cadets. They fulfil admirably the wartime aim of mass instructors: To teach so little to so many about so much. The cloud photographs in the meteorological pamphlet are really beautiful, especially the one of " vapour trails," which we do not remember seeing elsewhere.

MAPS AND ELEMENTARY METEOROLOGY FOR AIRMEN.

By W. Myerscough. Sir Isaac Pitman and Sons. 1942. 3/6.

Written by the author of " Rapid Navigation Tables," this book at once gains the reader's confidence by its good, solid binding, bold type and direct approach to its subject. It has the sure touch of the expert teacher who knows how to condense and simplify his subject so as to bring it within the grasp of his pupils. An excellent feature is the provision of four blank charts, representing different types of projection, on which the student can work exercises. We have verified that these sheets are soundly anchored in the book and printed on paper good enough to stand frequent erasures—two points that are often overlooked when practice charts are supplied.